Comparing Global Atmospheric CO_2 Flux and Transport Models with Remote Sensing (and Other) Observations

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We report recent progress derived from comparison of global CO2 flux and transport models with new remote sensing and other sources of CO2 data including those from satellite. The overall objective of this activity is to improve the process models that represent our understanding of the workings of the atmospheric carbon cycle. Model estimates of CO2 surface flux and atmospheric transport processes are required for initial constraints on inverse analyses, to connect atmospheric observations to the location of surface sources and sinks, to provide the basic framework for carbon data assimilation, and ultimately for future projections of carbon-climate interactions. Models can also be used to test consistency within and between CO2 data sets under varying geophysical states.

Here we focus on simulated CO2 fluxes from terrestrial vegetation and atmospheric transport mutually constrained by analyzed meteorological fields from the Goddard Modeling and Assimilation Office for the period 2000 through 2009. Use of assimilated meteorological data enables direct model comparison to observations across a wide range of scales of variability. The biospheric fluxes are produced by the CASA model at 1x1 degrees on a monthly mean basis, modulated hourly with analyzed temperature and sunlight. Both physiological and biomass burning fluxes are derived using satellite observations of vegetation, burned area (as in GFED-3), and analyzed meteorology. For the purposes of comparison to CO2 data, fossil fuel and ocean fluxes are also included in the transport simulations. In this presentation we evaluate the model's ability to simulate CO_2 flux and mixing ratio variability in comparison to remote sensing observations from TCCON, GOSAT, and AIRS as well as relevant in situ observations.

Examples of the influence of key process representations are shown from both forward and inverse model comparisons. We find that the model can resolve much of the synoptic, seasonal, and interannual variability in the observations, although reasons for persistent discrepancies in northern hemisphere vegetation uptake are examined. At this time, we do not find any serious shortcomings in the model transport representation, but this is still the subject of close scrutiny. In general, the fidelity of these simulations leads us to anticipate incorporation of real-time, highly resolved remote sensing and other observations into quantitative analyses that will reduce uncertainty in CO_2 fluxes and revolutionize our understanding of the key processes controlling atmospheric CO2 and its evolution with time.